CHAPTER V
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V. SYNTHESIS AND INTERPRETATION

Synthesis and interpretation of information is the fifth step in the six-step process for ecosystem analysis at the watershed scale. The purpose of step 5 is to compare current (step 3) and reference (step 4) conditions for key ecosystem elements, to explain significant differences, similarities, or trends, and to examine their causes. The capability of the ecosystem to achieve key management plan objectives is also evaluated in this step (Regional Ecosystem Office 1995).

Soils and Geology

While surface materials are quite erodible, relatively gentle slopes within the watershed help reduce overall erosion hazards. Large amounts of unconsolidated materials, of relatively young age, create large areas of risk for mass movement. These are most evident in the lower drainage within the landslide areas (Qls), and some of the upper headwaters of steep slopes. Productivity levels are generally high due to considerable amounts of deeper soils and favorable water availability. Glacial activity and resulting tills, in combination with volcanic ash deposits, have created alpine environments in places with high, wet meadow complexes. Desolation, Kelsay and other wet meadow systems provide favorable subsurface water storage and release.

Watershed Hydrology

Riparian Management

Riparian management concerns were persistent throughout the analysis, with many as yet unanswered questions. Moreover, the lack of adequate inventories and classification of riparian communities, precludes specific integration between resource areas. General management concerns and areas of potential conflict are presented below.

Riparian areas are essential landscape components in the maintenance and restoration of water quality and aquatic habitat. Riparian areas provide many other key functions including unique habitats for plants and wildlife. As a result of past and current land uses many riparian communities in the Desolation watershed are not in optimum condition. Streamside roads, logging, and grazing have altered vegetation communities, and stream channel morphology. Recent fires have also had a pronounced impact in the upper watershed.

Riparian areas are strongly affected by upslope conditions and activities. Current vegetation conditions in both burned and unburned areas reflect past management policies of fire suppression, and timber harvest. Concerns include recovering historic stand conditions and fire regimes to more sustainable levels throughout the watershed.

Riparian shrub communities were probably more extensive prior to grazing and fire management. The potential recovery of shrub communities is complicated by the impacts of continued livestock and ungulate grazing and the need to maintain future sources of large in-channel wood, which has many physical and biological functions. Active management within designated Riparian Habitat Conservation areas was considered, with the assumption that any actions in RHCAs must benefit riparian functions in some way.

Cumulative Effects

Water yield and peak flow increases, elevated erosion, sedimentation, and channel changes are more likely in watersheds with higher combined levels of harvest, roads and burned areas. Subwatersheds with increased risk of cumulative effects are: 36C, 36F, 36G, 3H, and 3I.

Wild and Scenic River Eligibility

The Wild and Scenic River Eligibility determination reported Desolation Creek as having excellent water quality, one of the "values" rated in the analysis. However, analysis of cumulative effects showed that water quality in Desolation is not at optimum. This result does not affect the Recreation or Scenic determination since impairment is not due to water quality conditions that affect aesthetic values (turbidity or nuisance algae). However, unless a water quality management plan is developed, South Fork Desolation may not meet one criterion for designation as "Wild", which requires meeting state standards. Elements of such a plan are contained in the Recommendation section of this report. Water temperatures in excess of standards represent natural conditions in South Fork Desolation Creek, and should not affect the determination for Wild and Scenic eligibility.

Forest Overstory Vegetation

Forest Cover Types

Table 54 and Figure 33 illustrate changes in forest cover types between 1939 and 1997. Stands dominated by lodgepole pine were much more abundant in 1939 than in 1997. The most likely reason for a reduction in the lodgepole pine cover type was a mountain pine beetle outbreak during the late 1970s and early 1980s that killed mature lodgepole pine throughout the central Blue Mountains (Gast and others 1991). After bark beetles killed the overstory trees, new stands were often dominated by shade-tolerant, late-seral species that had previously regenerated beneath the shade-intolerant, early-seral lodgepole pines. Since grand fir is a shade-tolerant, late-seral species, this scenario could help explain why the grand fir cover type increased by 120 percent (more than doubling in area) between 1939 and 1997.

The 500 percent increase in Engelmann spruce from 1939 to 1997 may have actually occurred, or the increase could merely be a reflection of the improved 1997photography. Spruce seldom occurs in pure stands. Mixed stands with a substantial spruce component may have existed in 1939, but would have been more difficult to discern on the low resolution photography of that era. Alternatively, fire suppression over the last 90 years has tended to blur the historical zonation of forest vegetation. Engelmann spruce is one species that has expanded its range to lower elevations as a result of fire suppression, so its apparent increase in abundance may be real.

The decrease in Douglas-fir is probably related to the landscape-level disturbances occurring over the last 60 years, particularly with respect to outbreaks of defoliating insects (Douglas-fir tussock moth and western spruce budworm), and bark beetles (primarily Douglas-fir beetle).

Table 51 indicates that two new forest cover types became established sometime between 1939 and 1997 – western juniper (CJ) and whitebark pine (CB). It is probable that western juniper did indeed become established during that period. Small areas of whitebark pine, however, were already present in 1939, but do not show up in the historic vegetation database. These areas were either too small to be distinguished, or were misidentified on the historical aerial photography, which was small-scale (1:20,000) and of lower resolution than modern film.

Western juniper trees are relatively common on hot dry sites at low elevations in the analysis area. Historically, juniper abundance and distribution was largely controlled by fire, since it has low fire resistance (Agee 1993) and would seldom survive any but the lowest-intensity burns. It is possible that the small amount of western juniper cover type identified in 1997 is a consequence of fire suppression.

Comparison of acres of non-forested cover types (grassland, shrubland, forbland/meadows, etc.) indicate an increase between 1939 and 1997. The reasons for this change are many and varied: in some cases, the effect of timber harvest or wildfire resulted in areas that currently have less than 10 percent canopy cover of trees, which caused them to be coded as a non-forest cover type. Eventually, those areas will support trees once again as plant succession progresses. In other instances, the better resolution and smaller scale of the 1995-1997 aerial photography allowed more of the "patchy" non-forest vegetation to be delineated as separate polygons (typically ranging from 1 to 3 acres). That level of detail or refinement was seldom possible on the coarser photography used for the 1939 characterization.

Although the percentage comparisons do represent substantial change in the species composition of the forest canopy, those changes are probably within the historic range of variation for species composition. Fluctuations in cover types have always occurred in response to forest disturbances, and are now occurring again in response to the Bull and Summit wildfires and other recent disturbance events. For example, one expected consequence of wildfires in the Desolation watershed is a future short-term (30-50 years) reduction in the subalpine fir, Engelmann spruce and grand fir cover types, and an increase in the lodgepole pine, western larch, and subalpine grassland cover types.

Table 54. Changes in Forest Cover Types, 1937-1997.

Cover Type	Predominant Tree Species	1939		1997		% Change in Total Acres
		Total Acres	% of Forested Acres	Total Acres	% of Forested Acres	
CA	Subalpine fir	8,003	12	5,667	8	-29%
CD	Douglas-fir	12,916	20	8,203	12	-36%
CE	Engelmann spruce	485	<1	2,916	4	500%
CL	Lodgepole pine	25,624	40	14,598	21	-43%
CP	Ponderosa pine	3,620	6	3,902	6	+8%
CT	Western larch	1,509	2	1,501	2	-1%
CW	Grand fir	12,021	19	26,459	38	120%
CX	Mixed	2,391	4	1,921	3	-20%
CB	Whitebark pine	0	0	116	<1	N/A
CJ	Western juniper	0	0	21	<1	N/A
Other	Non-forested	3,084	N/A	4,232	N/A	37%

Figure 33. Comparison of Cover Type Abundance, 1939-1937.

Forest Canopy Cover, Stand Density

Recently-developed stocking guidelines (Cochran and others 1994) were used to analyze stand density levels and infer whether they were ecologically sustainable. By using the stocking guidelines in conjunction with potential natural vegetation (PAGs) and information about the seral status of forest vegetation, it was possible to determine the acres that would be considered overstocked, and to compare results for reference and current conditions (Table 55 and 56). Details of the stand density analysis, which was used to help formulate treatment recommendations and opportunities, are found in the Silviculture Specialist's Report.

Table 55. Stand density analysis; 1939 forest conditions.

PAG	SS	TREE SPECIES	LMZ COVER	UMZ COVER	TOTAL AREA	OVER-STOCKED
					(Acres)	
Cold Dry Upland Forest	ES	LP	59	66	12,709	11,736
	MS	DF	72	78	2,357	216
	LS	SF	76	83	7,333	1,292
Cool Moist Upland Forest	ES	LP	58	65	11,129	10,565
	MS	DF	74	80	3,636	982
	LS	SF	74	81	11,042	2,556
Hot Dry Upland Forest	LS	PP	26	33	1,059	394
Warm Dry Upland Forest	ES	PP	43	51	5,855	5,242
	MS	DF	68	75	1,072	1,012
	LS	DF	68	75	10,376	3,075
TOTAL					66,568	37,070(56%)

Sources/Notes: Summarized from the 39veg database (see appendix 1 for more information). Acreage figures include private land located within the analysis area. ES refers to early seral; MS refers to mid seral; LS refers to late seral (see Hall and others 1995). Tree species codes, lower management zone (LMZ) values, and upper management zone (UMZ) values are described in appendix 2. The LMZ and UMZ figures are canopy cover values and refer to a "management zone" in which stand densities are considered to be ecologically sustainable (Cochran and others 1994). The "total area" figure shows the acreage of each PVG/SS combination in the analysis area; the "overstocked" value is the acreage with a canopy cover value that exceeds the "UMZ cover" figure and would therefore be considered overstocked.

Table 56. Stand density analysis; 1997 forest conditions.

PAG	SS	TREE SPECIES	LMZ COVER	UMZ COVER	TOTAL AREA	OVER-STOCKED
					(Acres)	
Cold Dry Upland Forest	ES	LP	59	66	9,677	1,484
	MS	DF	72	78	2,426	0
	LS	SF	76	83	11,315	63
Cool Dry Upland Forest	MS	DF	72	78	11	0
Cool Moist Upland Forest	ES	LP	58	65	6,304	325
	MS	DF	74	80	4,052	0
	LS	SF	74	81	14,424	366
Hot Dry Upland Forest	LS	PP	26	33	690	308
Warm Dry Upland Forest	ES	PP	43	51	3,402	358
	LS	DF	68	75	12,844	0
Warm Moist Upland Forest	ES	PP	55	62	44	44
	MS	DF	68	75	94	0
TOTAL					65,283	2,948 (4.5%)

Sources/Notes: Summarized from the 97veg database (see appendix 1 for more information). Acreage figures include private land located within the analysis area.

ES = early seral; MS = mid seral; LS = late seral (Hall and others 1995).

Tree species codes: (LMZ) = lower management zone values, (UMZ) = upper management zone values (see appendix 2). The "total area" figure shows the acreage of each PVG/SS combination in the analysis area; the "overstocked" value is the acreage with a canopy cover value that exceeds the "UMZ cover" figure and would therefore be considered overstocked.

It is interesting that approximately 56 percent of the Desolation watershed would be considered overstocked in 1939, as compared to only 4.5 percent in 1997, yet this apparent overstocking was not reflected in high levels of insect or disease damage for that time period (Tables 46 and 47). The high stocking levels, however, may have presaged the widespread bark-beetle outbreaks that occurred across the southern Umatilla National Forest in the mid to late 1940s (Buckhorn 1948), and an intense spruce budworm outbreak that began in 1944 and continued until 1958 (Dolph 1980).

High-density forest (canopy cover greater than 70%) was much more common in 1939 than in 1997 (Table 57). Conversely, low-density forest (canopy cover of 40% or less) is much more abundant currently than it was historically. Forest disturbances, both natural and human-caused, have contributed to substantial reductions in stand density through time. In some instances, clearcutting, lethal wildfire, or another major disturbance killed an entire stand, with the newly-regenerated, post-disturbance forest often having a lower density (canopy cover) than the original one. In other cases, partial-cutting timber harvests, spruce budworm defoliation, or a similar disturbance killed some trees but not the entire stand, thereby reducing the stand density (canopy cover).

Table 57. Comparison of Canopy Cover, 1939-1997.

Live Forest Cover Description	1939		1997		
	Acres	%	Acres	%	% Change in Acres
40 % or less	5,284	8	33,668	48	537
41% to 55%	4,108	6	16,190	23	294
56% to 70 %	16,329	23	13,142	19	-20
Over 70 %	40,848	59	2,304	3	-94

Forest Canopy Layers

Stands with two canopy layers were slightly more common in 1997 (71%) than in 1939 (64%, Table 58). Single-layer stands were more abundant in 1939 than in 1997, indicating that stand structure has become slightly more complex. Stands with three or more canopy layers have been relatively stable through time, occupying 4 percent of the watershed in 1939 and 6 percent in 1997.

Table 58. Comparison of Canopy Layers, 1939-1997.

Canopy Layer Description	1939		1997	
	Acres	%	Acres	%
Live tree canopy cover occurs in l layer	17,531	25	13,467	19
Live tree canopy cover occurs in 2 layers	44,830	64	49,194	71
Live tree canopy cover occurs in 3 or more layers	4,208	6	2,643	4
Non-vegetated and non-forested cover types	3,085	4	4,232	6

Forest Size Classes

Stands comprised of large-diameter trees were more common in 1939 than in 1997 (Table 59, Figure 34). In 1939, 85 percent of the analysis area had stands with trees in the small or medium size classes (9”to 31.9” DBH); by 1997, the percentage had declined to only 65 percent (based on size class 77 and greater). Conversely, the incidence of stands dominated by small diameter trees (seedlings and saplings) increased significantly during the same period (Table 59, Figure 36).

Table 59. Comparison of Forest Size Classes

Size Class Description	1939		1997		% Change in Acres
	Acres	%	Acres	%	
Small Trees (9" - 20.9" DBH)	45,281	65	44,157	63	-2%
Medium Trees (21" - 31.9" DBH)	14,163	<21	1,033	<2	-93
Large Trees (32" - 47.9" DBH)	0	0	7	<1	N/A

Primary causes of size-class changes include selective timber harvest of large diameter trees (Powell 1994); selective killing of large-diameter trees by some species of bark beetles (Gast and others 1991); and recent, stand-replacing wildfires initiating new stands that are now dominated by small, seedling-size trees.

Figure 34. Forest Size Classes, 1939 and 1997.

Forest Structural Stages

When analyzing current conditions with respect to structural stages, it is often helpful to put them in an historical context. Structural stages are inclusive – any particular point on a stand's developmental pathway can be assigned to a structural stage. They are also universal – every forest stand eventually passes through a series of structural stages, although not every stand passes through all of the stages or spends an equal amount of time in any particular stage. For those reasons – inclusiveness and universality – structural stages are an ideal framework for comparing current and reference conditions.

A technique was recently developed to compare current and reference conditions – the historical range of variation (HRV) (Morgan and others 1994). Although debate on the concept continues (B. Wales, ICBEMP Science Team, pers. comm. 1999), some managers consider HRV to be an indicator of ecological sustainability. After identifying historical ranges for a particular variable, managers can then infer which ecological processes may have been important for creating and sustaining those conditions. HRV may be most valuable as a reference point or benchmark.

A key premise of HRV is that native species are adapted to, and have evolved with, the natural disturbance regime of an area. As such, ecosystem elements occurring within their historical range are believed to represent diverse, resilient, productive, and sustainable situations (Swanson and others 1994). Since structural stages represent different points in the development of a forest, they can serve as a valueable framework for assessing the condition of habitat for native wildlife, fish and understory flora.

An HRV analysis was completed for the Desolation watershed. It was based on two primary factors – forest structural stages and potential natural vegetation (as represented by PVGs). Potential natural vegetation was important for explicitly recognizing that all forest stands will not occupy every structural stage, and that different types of forest (dry, moist, cold) will not spend the same amount of time in any particular stage.

Results of HRV comparisons are provided in Table 60. Table 60 also summarizes current and historic percentages of each structural stage, by PVG, for two groupings of subwatersheds in the Desolation analysis area. Results are also provided for the watershed in its entirety. Subwatershed groupings were developed because it was recommended that an HRV analysis be conducted on land areas of 15,000 to 35,000 acres (USDA Forest Service 1994).

The Desolation watershed has a pronounced elevational gradient spanning almost 5,000 feet (2,971 to 7,632 feet), resulting in a well-balanced mix of upland forest PVGs. Unfortunately, partitioning the watershed into two smaller groups essentially disrupted the good balance. For that reason, the HRV analysis pertaining to the whole watershed is considered to be the most accurate, even though it pertains to an area that exceeds 35,000 acres.

When considering the entire Desolation watershed, the HRV analysis for current structural stages (Table 60) shows that ***old forest*** structure is deficient for all PVGs. ***Young forest multi strata*** is also deficient for the dry forest PVG. The ***stand initiation*** structural stage exceeds the historical range**,** often by a considerable amount, for all three of the PVGs. ***Stem exclusion* and *understory reinitiation*** also exceed the historical range in the dry forest PVG.

By comparison, in 1939, ***old forest*** structure exceeded the historical range in the dry forest PVG. The ***young forest multi strata*** structural stage was deficient for the dry forest PVG. The percentage of all other stages occurred within their historical ranges. Table 61 and Figure 35 illustrate changes in proportions of the watershed in each structural class between 1939 and 1997.

Table 60. HRV analysis and comparisons for structural stages; 1939 and 1997 forest conditions.

GROUP	PVG		SI	SE	UR	YFMS	OF	ACRES
LOWER	Cold UF	HRV	5-20	5-35	1-25	10-40	5-40	
		1997	**74**	3	8	13	2	5,062
		1939	6	**46**	1	7	41	4.019
	Moist UF	HRV	1-10	5-25	1-20	20-50	10-60	
		1997	**50**	10	**27**	13	0	10,185
		1939	7	10	3	21	59	10,064
	Dry UF	HRV	5-15	5-30	1-10	5-25	5-70	
		1997	16	**60**	**22**	0	3	13,613
		1939	6	9	1	0	**85**	14,592
UPPER	Cold UF	HRV	5-20	5-35	1-25	10-40	5-40	
		1997	**75**	8	1	12	4	18,367
		1939	20	31	1	23	26	18,378
	Moist UF	HRV	1-10	5-25	1-20	20-50	10-60	
		1997	**61**	3	3	32	2	14,733
		1939	9	18	4	26	43	15,742
	Dry UF	HRV	5-15	5-30	1-10	5-25	5-70	
		1997	**65**	31	4	0	0	3,323
		1939	**17**	3	0	4	77	3,772
Total	Cold UF	HRV	5-20	5-35	1-25	10-40	5-40	
		1997	**75**	7	2	12	4	23,429
		1939	17	33	1	20	28	22,397
	Moist UF	HRV	1-10	5-25	1-20	20-50	10-60	
		1997	**56**	6	13	24	1	24,918
		1939	8	15	3	24	49	25,806
	Dry UF	HRV	5-15	5-30	1-10	5-25	5-70	
		1997	**26**	**54**	**18**	0	2	16,936
		1939	8	7	1	1	83	18,364

Sources/Notes: Summarized from the 97veg database (see appendix 1 for more information). Current percentages include private land located within the analysis area.

(HRV) = Historical percentages / (PVG) = Potential vegetation group

"Group" = SWS grouping developed for the HRV analyses

"Total" = HRV situation for entire analysis

SE = stem exclusion (SEOC + SECC) / OF =old forest (OFMS + OFSS).

Shaded cells indicate those instances where the current percentage (1939) is above the historical range for that structural stage. Cells enclosed in a box indicate those instances where the given percentage is below the historical range. Deviations (whether above or below the HRV range) were noted when the given percentage differed by 2% or more.

Table 61. 1939-1997 Structural Stage Comparisons.

STRUCTURAL STAGE	TOTAL 1939 ACRES	TOTAL 1997 ACRES	% CHANGE IN TOTAL ACRES
OFSS	18,946	800	**-96**
OFMS	15,390	781	**-95**
YFMS	10,909	8,802	**-19**
UR	1,184	6,761	**471**
SECC	12,641	5,195	**-59**
SEOC	72	7,021	**9651**
SI	7,427	35,944	**384**

If one assumes that the 1939 conditions represent a largely unmanaged or unmodified situation (at least with respect to a lack of timber harvest), then the reference condition HRV analysis might indicate that the historical ranges used are reasonably accurate. If that wasn't the case, then one would have expected more deviations in current percentages (above or below the historical ranges) than actually occurred. Since few human-caused changes had affected forest conditions by the late 1930s, the apparent accuracy of the historical ranges would indicate that they adequately reflect the natural disturbance regime of the analysis area.

Figure 35. Structural Stage comparisons, 1939-1997.

Landscape Patches

"Fragmentation" as used in this analysis refers to changes in the size, distribution, and/or connectivity of similar "patches" of forest vegetation. Fragmentation of primary natural forest has been a recent concern, as the shrinking and/or outright loss of viable patches of old forest continues (Noss and Cooperrider 1994).

Table 62 contrasts patch characteristics by cover type between 1939 and 1997. While the overall numbers of patches has remained almost unchanged over that period (331 vs 334), patch characteristics for some forest cover types and structural stages have changed substantially. Lodgepole pine had a larger mean patch size in 1939 (434 acres) than in 1997 (189 acres). Subalpine fir, Douglas-fir, and western larch on the other hand experienced patch size decreases between 1939 and 1997. Mean patch size for Engelmann spruce, ponderosa pine, grand fir, and mixed conifer increased between 1939 and 1997.

Table 62. Patch Characteristic Comparisons, 1939-1997.

COVER TYPE	PREDOMINANT TREE SPECIES	1939 # OF PATCHES	1997 # OF PATCHES	% CHANGE IN # PATCHES	1939 AVE. PATCH SIZE	1997 AVE. PATCH SIZE	% CHANGE IN PATCH SIZE
CA	Subalpine fir	23	28	22	348	192	-45
CD	Douglas-fir	85	63	-26	152	130	-14
CE	Engelmann spruce	10	15	50	48	194	304
CL	Lodgepole pine	59	77	31	434	189	-57
CP	Ponderosa pine	35	24	-31	103	162	57
CT	Western larch	22	41	86	68	36	-47
CW	Grand fir	80	66	-18	150	401	167
CX	Mixed	20	15	-25	119	128	8
CB	Whitebark pine	0	1	NA	0	117	NA
CJ	Western juniper	0	1	NA	0	21	NA
TOTAL		334	331	-1	NA	NA	NA

Table 63 provides a comparison of patch size by structural stage. Patch size appears to have *increased* significantly for some structural stages (e.g. SI patch size), and thus are now certainly more connected and more continuous than in 1939. Conversely, both maximum and average patch size for the old forest structural stages are significantly smaller than in 1939. The SECC and YFMS stages also had larger mean patch sizes in 1939 than in 1997.

Table 63. Summary of Patch Analysis for Structural Stages, 1939 and 1997.

STRUCTURAL STAGE	1939 # PATCHES	1997 # PATCHES	CHANGE IN NUMBER OF PATCHES	1939 AVERAGE PATCH SIZE (ACRES)	1997 AVERAGE PATCH SIZE (ACRES)	% CHANGE IN AVERAGE PATCH SIZE
OFMS	72	14	-58	214	56	-74%
OFSS	85	22	-63	223	36	-84%
SECC	69	49	-20	183	106	-42%
SEOC	3	100	+97	24	70	192%
SI	117	75	-42	63	476	656%
UR	12	35	+23	98	193	97%
YFMS	73	60	-13	149	146	-2%

Forest Disturbances

"Healthy" forests are able to tolerate periodic disturbances and may even depend on them for renewal. Such forests maintain their integrity, resiliency and productive capacity over time. Forest integrity involves sustaining a wide range of ecological processes whereby plants, animals, microorganisms, soil, water and air are constantly interacting. These processes form soils, recycle nutrients, store carbon, clean water, and fulfill other functions essential to life. Significant changes in the level or pattern of natural disturbances may be an indicator of impaired forest health.

The effects of forest disturbances were more apparent in 1997 than in 1939 (Table 64). In particular, the effects of anthropogenic disturbances (primarily timber harvest) were more obvious in 1997 than in 1939. The impacts of recent wildfires (Bull and Summit) were readily observed on the 1995-1997 aerial photography. No similarly recent burned areas were visible on the historical photographs, however, patterns from older fires were apparent. It is believed that the lack of obvious disturbance indicates that the late 1930s and early 1940s were a particularly quiescent period in the Desolation watershed, although significant changes were on the way in the form of bark-beetle and spruce budworm outbreaks that would begin in 1944 or 1945 (see Table 14 in Upland Forest Vegetation Analysis, in Appendices).

Table 64. Forest Disturbances, 1939 and 1997.

Overstory Mortality Description	1939		1997	
	Acres	%	Acres	%
Low; 10 dead TPA	66,569	96	47,653	69
Moderate; 11-20 dead TPA	0	0	12,356	18
High; 21-60 dead TPA	0	0	2,315	3
Very high; 60 dead TPA	0	0	2,980	6

Insects and Diseases

The last 20 years have been a period of rapid change in the forests of the Desolation watershed. Substantial portions of the analysis area were affected by a mountain pine beetle outbreak in the late 1970s and early 1980s, western spruce budworm outbreaks in 1944-1958 and 1980-1992, and outbreaks of Douglas-fir beetle and fir engraver during the late 1980s and early 1990s (Gast and others 1991). A prolonged dry period in the late 1980s and early 1990s exacerbated those problems by reducing tree vigor and lowering stand resistance to insect damage.

A computerized model was used to estimate current risk (susceptibility) for 14 insects and diseases present in the analysis area. Risk ratings were calculated for both the 1939 and 1997 vegetative conditions, thereby facilitating a side-by-side comparison of risk trends. The results of that analysis are provided in Table 60. When comparing risk only, the table shows increased susceptibility to several insects and diseases Assessment of Forest Sustainability between 1939 and 1997.

Table 65. Insect and Disease Risk Rating Comparisons, 1939-1997.

INSECT OR DISEASE	RISK RATING	1997 (ACRES)	1939 (ACRES)	CHANGE (ACRES)
Douglas-fir Beetle	High	27,812	10,296	17,516
	Moderate	1,505	18,494	-16,989
	Low	37,022	34,569	2,453
Douglas-fir Dwarf Mistletoe	High	15,727	9,030	6,697
	Moderate	7,088	17,733	-10,645
	Low	43,524	36,524	7,000
Fir Engraver	High	19,220	41,680	-22,460
	Moderate	1,100	317	783
	Low	46,019	21,362	24,657
Indian Paint Fungus	High	8,937	1,774	7,163
	Moderate	32,727	22,909	9,818
	Low	24,657	38,359	-13,684
Mountain Pine Beetle (Lodgepole Pine)	High	2,892	3,845	-953
	Moderate	1,736	16,232	-14,496
	Low	61,711	43,282	18,429
Mountain Pine Beetle (Ponderosa Pine)	High	736	532	204
	Moderate	691	1,302	-611
	Low	64,912	61,525	3,387
Ponderosa Pine Dwarf Mistletoe	High	7,811	3,679	4,132
	Moderate	4,400	3,718	682
	Low	54,128	55,645	-1,517
Mixed Conifer Root Diseases	High	28,614	30,980	-2,366
	Moderate	37,359	31,191	6,168
	Low	366	747	-381
Schweinitzii Root and Butt Rot	High	38,836	22,179	16,657
	Moderate	26,779	38,483	-11,704
	Low	724	2,380	-1,656
Spruce Beetle	High	0	0	0
	Moderate	0	0	0
	Low	56,499	61,370	-4,871
Western Spruce Budworm	High	49,206	40,569	8,637
	Moderate	12,768	17,988	-5,220
	Low	2,828	3,941	-1,113
Tomentosus Root and Butt Rot	High	3,109	2,387	722
	Moderate	143	546	-403
	Low	63,087	60,109	2,978
Douglas-fir Tussock Moth	High	0	0	0
	Moderate	52,176	20,218	31,958
	Low	14,163	43,141	-28,978
Western Larch Dwarf Mistletoe	High	16,226	7,996	8,230
	Moderate	14,005	15,971	-1,966
	Low	36,108	39,075	-2,967

Sources/Notes: From the UPEST risk calculator (Ager 1998). "Change" column uses 1939 as the base year.

Fire/Fuels

Low Severity Natural Fire Regime Areas

Because of the frequent fire return interval naturally inherent to the dry forests of the ponderosa and warm/dry potential vegetation groups, these stands have been impacted most by seral transition since the advent of fire suppression. With an average fire return interval of approximately 10 years, it is likely that these stands have missed 5-8 fire return events that would have modified the vegetation composition of the forest as well as modifying the vertical continuity of the fuels. This would be the result from frequent low intensity fires as the less fire resistant tree species such as grand fir and Douglas-fir were killed while in the seedling and sapling stages. So lower stand densities were maintained and, more specifically, fewer trees were present in the lower levels of the forest canopy to provide ladder fuels to the crowns of the dominant trees.

Mixed Severity Natural Fire Regime Areas

Management practices such as total fire suppression, without an offsetting prescribed fire program, and harvest practices that favor shade tolerant species such as grand fir, have created a landscape continuity of densely stocked stands highly susceptible to insects, disease, and stand replacing fire. In many cases, fire intensities and the potential extent of these fires are increased due to insects and/or disease mortality, which increases the amount of available fuel.

High Severity Natural Fire Regime Areas

The impacts of management have been limited here, but continuing to suppress all fires without some other means to create new "large" scale patterns of varying age classes and seral stages will likely result in stand replacing fires becoming more extensive than in a historic fire regime. The Umatilla National Forest portion of the 1996 Summit Fire was largely confined within this fire regime area, and resulted in a large portion of this area being left with a mosaic of stand structures.

Understory and Non-Forest Botanical Resources

Culturally Significant Plants

Changes in land management have altered the plant communities that were present prior to Euro-American settlement, which has altered the availability of culturally significant plants. During pre-settlement and very early settlement times, light grazing pressure and frequent fire allowed berry bushes, especially huckleberry (*Vaccinium* spp.), serviceberry (*Amelanchier alnifolia*), chokecherry (*Prunus virginiana*), bitter cherry (*Prunus emarginata*), and elderberry (*Sambucus cerulea*) to be widespread, large, and highly productive, making up a significant portion of Native Americans' food source (see Kay, 1994 for a more complete discussion and further references).

Most of the shrubs present in the watershed are highly fire adapted, and sprout readily when the plants are fairly young and/or after a cool fire (which is one of the reasons that Native Americans burned frequently—to rejuvenate the berry grounds). However, after years of fire suppression, and weakness caused by age and competition from later seral species, most shrubs are killed by the hot fires that usually occur in the present time.

The grass steppes and root grounds ("scab flats") have changed with changes in land management practices. While these areas look "barren" to the untrained eye, in a "pristine" state they can actually be some of the most diverse communities, are relatively fragile, and can take centuries to recover from impacts. Extensive domestic grazing has turned what were once dry grassy meadows into dry rocky scabflats with little topsoil left. Over the years, trampling has broken up the cryptobiotic crusts and stream banks, causing extensive soil erosion in many places and loss of wet meadow habitats besides streams. Plant populations, and suitable habitat for species such as camas (*Camassia quamash*) and biscuitroot (*Lomatium* spp.) have been reduced.

Noxious Weeds

Unfortunately, noxious weeds are probably here to stay. These species have the potential to alter the plant communities and ecological processes as profoundly as the excessive grazing of the late 1800's or the exclusion of fire in the 1900's. They are noxious because of their ability to colonize disturbed areas, invade relatively undisturbed areas, outcompete other vegetation. Most of them propagate readily, and/or have long-lived seed that is easily transported long distances. There are large areas at the Forest boundary that are almost solid yellow star thistle. A conversion of a native plant community to a virtual monoculture of noxious weeds removes food and cover for the entire food chain, from small insects to large game animals and predators. They can make rangelands unfit for any ungulates, native or domestic.

Most noxious weeds found on the Umatilla are taprooted and are very poor at holding soil in place, leading to erosion, loss of topsoil and sedimentation of streams. Only 6 of the 14 tracked noxious weed sites (as of spring, 1998) in the Desolation watershed have been cleared through the NEPA process in the Noxious Weed Environmental Assessment. The other 8 known sites, and any new sites, can only be treated manually until the updated noxious weed Environmental Impact Statement is finished. Every year that this is delayed gives these weeds another year to establish a bigger root system and add to the seedbank, making it more difficult to eradicate them.

Sensitive Species

The biology of *Botrychium* spp. is just beginning to be researched, and almost nothing is known about the results of management activities on these plants. Research to date shows them to be strongly mycorrhizal. This trait allows plants to sustain themselves without emerging from the ground every year to photosynthesize. One species almost never emerges from beneath the duff. This can make surveying for them difficult. The seeming absence of plants during any single survey in potential habitat does not necessarily mean that the plants are not present.

Fish and Aquatic Habitat

The Interior Columbia Basin Ecosystem Management Project (ICBEMP) Draft Environmental Impact Statement (DEIS) (1997) classifies all four sub-basins in the John Day Basin as Category 2 (moderate integrity). In that context, ratings from the ICBEMP databases (AQINTEG5, CRBFISH6, CRBFISH5, CRBFISH4) show Desolation Creek aquatic habitat integrity as high or medium *compared to the remainder of the John Day River Basin* (Figure 15).

Subwatersheds 36H and 36F have experienced the largest acreages of timber harvest (Table 66) but because of recovery since some of the earlier harvests and differences in harvest prescriptions over the years, when timber harvest is presented in equivalent clearcut acres as a percentage of the subwatershed, 36F (Battle) and 36C (Kelsay) show the greatest *present equivalent* harvest (Table 13).

Table 66. Desolation Creek Watershed - Total Acres of Timber Harvest, 1971 – 1993.

YEAR	36A	36B	36C	36D	36E	36F	36G	36H	36I
1971		25	73						
1972								157	
1973							390	4571	124
1974									
1975									
1976								88	
1977	131	713	2	5	2617	1309	10		
1978	228	341				135			
1979				242		336			
1980		2		179					
1981			215	379	11	449			
1982		88	241	170	10	293			
1983				510	38	279	20		
1984		23	40		40	34	135		
1985		39	20	16	74	236			
1986	19	165	57	102		232			
1987		42	29	83		41			
1988			126	197		27	35	76	
1989		220	652	327	295	21			
1990								607	
1991					26				
1992	36			34	45	868	90		
1993			3						
Total harvest acres, 1971-93	414	1658	1458	2244	3156	4260	680	5499	124
1998 Equivalent Clearcut Acres	7.8	135.6	395.3	485.1	191.7	813.3	116.0	349.7	0.0
ECA as % of Forested Acres	0.2	1.7	6.4	5.1	5.4	8.4	1.9	4.8	0.0

Water Temperature

Over the period of record, none of the streams in the Desolation watershed met the Oregon Department of Environmental Quality (DEQ) standards for bull trout streams or for chinook spawning streams. No stream met Pacfish standards for all years of record (some met the standard in some years). Junkens Creek and South Fork Desolation are probably the coolest in this watershed, but overall, streams here are too warm to meet the needs of chinook salmon and bull trout. In the Desolation watershed, water temperature is probably the most limiting habitat factor for native salmonids.

Pre-fire water temperatures in South Fork Desolation Creek, and current conditions in Junkens Creek could be used to represent temperature potentials for Desolation Creek tributaries. The two subwatersheds are “minimally” disturbed and exhibit relatively good water quality. Water temperatures in these two tributaries do not meet state standards for bull trout, yet are nominally affected by management activities. This fact suggests that there is low potential for maximum summer water temperatures to achieve the 50 degree F standard. An achievable target maximum standard for tributaries should be in the 55 to 60 degree F range.

Pool Frequencies

As averaged over entire subwatersheds, or over the entire length of Desolation Creek, pool frequencies range from more than double to less than half the 50th percentile for *unmanaged* reaches in ERU 6. South Fork Desolation (36I) and Howard (36G) subwatersheds had the highest pool frequencies in recent USFS surveys. Junkens-Beeman (36E), Kelsay (36C) and North Fork Desolation (36H) had the lowest pool frequencies. Although differences in data formats do not permit direct numerical comparisons between recent USFS survey data and data from ODFW's 1963-64 surveys, it may be significant that North Fork Desolation went from having the highest pool frequency in the 1963-64 ODFW reports, to among the lowest in 1992-93 USFS surveys.

Available resources do not presently permit comparisons to possible management changes over that period, but this might be a fruitful area for future study. North Fork Desolation presently has the second hightest road density in the watershed, and also a relatively high road/stream crossing density (Figure 38), and highest total timber harvest acreage (Table 66).

Pool frequencies throughout the Desolation watershed are not comparable to Pacfish standards, because Pacfish specifies pool frequencies in low gradient (<= 1%), C-type channels. With the possible exception of a few very short sections, streams in the Desolation watershed do not fit this criteria.

Riffle Depth/Width Ratios

When depth/width ratios of Desolation tributaries are averaged over entire subwatersheds, all save one rank above the 50th percentile for ERU 6 (Figure 29). That single case comes from South Fork Desolation Creek, downstream of the roadless area.. Ratios for mainstem Desolation Creek, on the other hand, compare unfavorably to the ERU 6 50th percentile. Although this condition may be related to past management, it may also be at least partly an artifact of the mainstem's larger size. Width/depth ratios throughout the Desolation watershed are not comparable to Pacfish standards, because Pacfish specifies width/depth measurements in low gradient (<= 1%), C-type channels. With the possible exception of a few very short sections, streams in the Desolation watershed do not fit this criteria.

Large Wood Frequency

Large wood frequency in Desolation Creek is, in most cases, below the 50th percentile for ERU 6 (Figure 26), although when compared to only the John Day Basin most streams rate better, particularly high gradient streams. Neither do most subwatersheds reach Pacfish standards, two exceptions being South Fork Desolation (36I) and Kelsay (36C) Subwatersheds .

Units for evaluating wood frequency do not take into account one important parameter: the productivity of the site. It would be entirely reasonable to expect more wood in small streams flowing through forest types that are highly productive or potentially highly productive of large wood than for streams flowing through sites that are inherently less productive. This would not hold for streams large enough to move the wood long distances during high streamflows, at least not in the same way. Most of the tributary streams of Desolation Creek probably seldom or never produce enough flow to move wood in the USFS stream survey large (>20" x 35') category. Only a very few would even move wood in the ICBEMP large (>12" x 35") category for long distances. To evaluate wood frequency in this way, two additional information sets would be needed: 1) Riparian zone productivities, and 2) Stream and tributary annual peak flows. This information has not yet been developed for the Desolation Drainage, but it is at least conceptually feasible to derive it from vegetation mapping work in progress and bankfull width and depth measurements from the stream survey records.

Stream Channel Sedimentation

There seems to be no widely accepted standard for evaluating stream channel sedimentation relative to the needs of Northwest salmonids. Nevertheless, research has clearly demonstrated that excessive stream sedimentation degrades both spawning and rearing habitat. Because the dominant or subdominant substrate in some of the tributary streams is of the sand size, sediment is probably a secondary concern in habitat degradation, (after temperature). Note, however, that several of the reaches having fine sediment as the dominant substrate flow through meadows, where fine sediment would be the expected substrate.

Subwatershed Comparisons

Table 58 represents an attempt to compare overall aquatic habitat quality between subwatersheds. A major drawback to such a comparison is that it treats all habitat parameters as if they were of equal importance, which may not be true, since a severe deficiency in one parameter may make habitat nearly useless and, in other cases, a strength in one parameter may partially compensate for weakness of another. Recognizing its limitations, it is an attempt to compare aquatic habitat quality between subwatersheds, and to relate relevant findings to the management history of the watershed. Hopefully some management recommendations can then be derived from those observed relationships.

One condition immediately apparent is that most subwatersheds differ little in their overall score (Table 67). Two exceptions are 36G (Howard) and 36I (South Fork Desolation). It may not be coincidental that these two subwatersheds contain the lowest road density, the lowest road crossings density, and the smallest percentage of the subwatershed in equivalent clearcut acres of any subwatersheds in the Desolation drainage. South Fork Desolation also has the smallest percentage of the subwatershed included in a grazing allotment.

Table 67. Aquatic Habitat Comparisons Between Subwatersheds.*

	Parameters					
Subwatershed	**Pool Frequency**	**Large Wood Frequency**	**Depth/Width Ratio**	**Sediment**	**Water Temperature**	**Average Score[1]**
36A	no data**	no data**	no data**	no data**	poor (3)	insufficient data
36B	no data*	no data*	no data*	no data*	no data*	no data**
36C	poor (3)	good (1)	good (1)	poor (3)	poor (3)	2.2
36D	no data**	no data**	no data**	no data**	fair (2)	insufficient data
36E	poor (3)	poor (3)	good (1)	poor (3)	good (1)	2.2
36F	poor (3)	poor (3)	good (1)	fair (2)	fair (2)	2.2
36G	good (1)	poor (3)	good (1)	good (1)	fair (2)	1.6
36H	poor (3)	poor (3)	good (1)	fair (2)	fair (2)	2.2
36I	good (1)	fair (2)	good (1)	fair (2)	good (1)	1.4
Mainstem	good (1)	poor (3)	poor (3)	good (1)	poor (3)	2.2

* Values represent relative quality of habitat parameter as compared to other subwatersheds within the Desolation watershed.
** Tributaries were not surveyed in these subwatersheds.
1 The smaller the average score, the better the habitat conditions.

In general, the most efficient approach to maintaining ecosystem process and function is to identify and protect areas least disrupted by human activities, and initiate restoration efforts in areas of greater disruption. The greatest potential for restoration would usually be in areas where substantial portions of the ecosystem remains intact and the knowledge and technology needed for effective restoration are available.

In this context, South Fork of Desolation (36I) and Howard Creek (36G) subwatersheds would seem to merit a "protect and maintain" management strategy, while subwatersheds 36C, E, F, and H might better fit the "restore" strategy for aquatic habitat.

Subwatersheds 36A, B and D are composed largely of private land; little information about past management or aquatic habitat quality in tributary streams is available for this portion of the drainage. It is, therefore, not feasible to develop subwatershed-wide management strategies for these subwatersheds.

There has been some gully and channel erosion with attendant water quality concerns in Desolation Meadows. This may be related to past grazing practices.

Some subwatersheds have lower road - stream crossing density in proportion to their total road density than others (compare Kelsay and North Fork Desolation in **Figure 18**). This is probably best explained by the different locations of roads in different subwatersheds. Subwatersheds with most roads on ridgetops or otherwise well away from streams could be expected to show a lower crossings density than subwatersheds with most roads in canyon bottoms or on lower mid-slopes. Mapping of road - stream crossings (Figure 36) appears to bear this out. To the extent that crossings density indicates road proximity to streams, and other factors (slopes, soils, etc.) being equal, subwatersheds with lower crossings density might be expected to show less degradation of aquatic habitat.

Figure 36. Road Density

Aquatic Habitat Management Strategies

An important part of the aquatic habitat management strategy is the Riparian Habitat Conservation Area (RHCA). RHCAs can serve as an important part of watershed management by supporting at least four important functions or components of aquatic habitat:

1) Instream woody debris

   Instream woody debris is produced within the RHCAs of Class 1, 2 and 3 streams, and is itself a component of several other important habitat parameters. Much of the woody debris for Class 4 streams may come from outside of the Pacfish RHCA. Instream woody debris functions as hiding and escape cover for fish, a food source for some aquatic invertebrates (thus indirectly for fish), provides pool forming structures, helps trap sediment and agrade the stream channel, increases stream roughness and dissipates energy, and in general adds to habitat complexity.

2) Stream Shade

   Living trees within RHCAs provide shade to the stream and thus function importantly in maintaining low water temperatures. They also support insects that may eventually serve as food for fish. The distance over which trees provide shade to the stream varies with tree height, hill slope, latitude and aspect. Geier-Hayes, Hays and Basford (1995) give a methodology for calculating tree shade length based on these parameters. Although this methodology was developed for silvicultural purposes (provision of sufficient shade to regeneration sites), it appears that it could be readily adapted to stream shading purposes. It would appear that, in most areas, all important shade over the stream would be provided by trees within one tree height of the stream channel. However, the specific RHCA widths necessary for this function could be calculated for various combinations of aspect and slope at the latitudes of the Desolation Watershed.

3) Erosion control and sediment trapping

   Management activities such as timber harvest, roads, and livestock grazing all hold the potential for contribution of excess sediment to streams. Leaving a strip of unmanaged land between management facilities or activities and the stream channel can help trap sediment before it enters the stream, provided that the sediment flow is non-channelized. A review by Belt et al. (1992) concluded that non-channelized sediment flow rarely travels more than 300 feet, and that 200 to 300 feet wide filter strips are generally effective at protecting streams from sediment from non-channelized flow.

4) Effects to riparian microclimate

   Riparian microclimate conditions may extend as far as three tree heights for at least one parameter (relative humidity, FEMAT, 1993). Other microclimate attributes appear to lose their riparian character within two tree heights or less from the stream bank. If vegetation is removed up to or within the riparian zone, an edge is created that may affect the interior microclimatic conditions of the riparian community.

Of the four reasons cited above for establishing RHCAs, the third, a sediment filter strip, would usually be satisfied with a 300-foot wide buffer on each side of the stream channel. The first two (woody debris and shade) are satisfied by a buffer width of one tree height. Riparian microclimate conditions could be supported by one or two additional tree heights beyond the "true" riparian zone, which may be much more or less than the Pacfish RHCA width. This seems prudent, especially for the more arid, Eastside forest types found in the Blue Mountains. Some forms of forest vegetation management could be appropriate or even important in this outer microclimate buffer.

Clearly, different components of riparian support to aquatic habitat require different buffer widths.

Pacfish specifies RHCA widths as two tree heights or 300 feet, whichever is greater, for fishbearing (Class 1 and 2) streams. One tree height or 150 feet, whichever is greater, is required for non-fishbearing perennial (Class 3) streams. Since average maximum tree heights in Desolation are generally less than 150 feet, the linear distance criteria would apply here.

In most cases the Pacfish RHCAs for Class 1 and 2 streams will be adequate to support all of the above components. However, the same does not hold true for Class 3 streams, since most of the functions given in items one, two, three and four above are just as important in Class 3 streams as in Class 1 or 2 streams. Wood is not needed here for fish habitat complexity, but its function in sediment detention and stream roughness are just as important in Class 3 as in Class 1 or 2 streams. Certainly shade to maintain cool water temperatures is important in reaches upstream of fishbearing portions of streams. It is therefore difficult to understand from an aquatic habitat perspective why RHCAs should be narrower in Class 3 than in Class 1 or 2 streams.

The smaller Pacfish RHCA widths for intermittent (Class 4) streams are easier to understand, since these streams, by definition, do not flow during the time when shade is needed to moderate water temperature increases and because of their smaller sizes, smaller woody debris would meet the needs for sediment detention. However, Class 4 streams are be just as vulnerable to sediment introduction as any other class of stream. Once sediment begins moving as channelized flow, it may travel a very long way, well into the Class 3 or 2 or 1 streams. Wherever there is genuine risk of sediment production by management activities, it is difficult to see why Class 4 streams would need less protection than larger streams, regardless of the presence or absence of fish.

The most effective design of Riparian Habitat Conservation Areas would account for local conditions, of both the stream and the terrestrial environment nearby, and also the type of contemplated management activity. Where water temperature is a concern, RHCA design would ensure ample shade to the stream (minimum buffer width of one tree height). Where fish cover and habitat complexity are of concern, RHCA design would ensure that plenty of wood would remain available for present and future needs (minimum buffer width of one tree height). Where non-channelized sediment flow is a concern, buffer width sufficient to prevent its reaching the stream channels would be assured (minimum buffer width of 300 feet). Where riparian microclimate is a concern, RHCAs would ensure sufficient vegetation bordering the true riparian to maintain the natural riparian microclimate.

Terrestrial Wildlife

Habitat

Changes in the relative availability of habitats from 1939 to the present are shown in Table 59 and Figures 39-45. In general, old growth forests, riparian hardwood shrub corridors, and aspen stands have declined in both quantity and quality, while stands of young conifers have increased in abundance.

Old Forest Habitat

The increasing rarity, fragmentation and degradation of late/old forest habitats and riparian systems are of concern across the Blue Mountains. In the Desolation drainage, the availability of old forest habitats has declined dramatically in just half a century. Old forest currently occupies 1,581 acres, or approximately 2 percent of the forested acres in the watershed, as compared to 34,335 acres, or 49 percent of the forested acres in 1939 (Table 68).

Table 68. Changes in Old Forest Habitat Availability, 1939-1997, Desolation Watershed.

FOREST PVG	STRUCTURAL STAGE	1939 ACRES	1997 ACRES	% CHANGE FROM 1939
Cold Upland	OFMS		264	**-85%**
	OFSS		632	
	Total		**896**	
Dry Upland	OFMS		300	**-97%**
	OFSS		75	
	Total		**375**	
Moist Upland	OFMS		217	**-98%**
	OFSS		93	
	Total		**310**	
Grand Total			**1581**	**-95%**

Under the Forest Plan C1 Old Growth network, emphasis was on retaining some of the remaining stands of old growth, but without any effective provision for the movement of late/old stands in and out of the forested landscape over time. While areas “capable” of supporting old growth forest were delineated, no site-specific management plans have been implemented to begin to move these areas toward functional old forest structure. Active management within C1 stands was largely precluded in favor of a “preserve” approach. Across the Umatilla NF, many potential old forest “replacement” stands were harvested over the last decade, precluding replacement options. The same is true of the Desolation Analysis Area, where some C1 areas have been informally “re-sited” after the originally-designated area was fragmented or removed in various timber sales.

There have also been significant changes in the size of old forest patches since 1939. Changes in patch size are summarized in Table 69 (see the Vegetation section for complete information).

Table 69. Changes in Forest Patch Size, 1939-1997

STRUCTURAL STAGE	1939		1997	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
OFMS	214	6,271	56	252
OFSS	223	4840	36	129

Dead Standing and Down Wood Habitat
Lacking any quantitative data for 1939, it is difficult to draw direct conclusions as to changes in snag and down wood density, size class distribution or spatial distribution. **NEED MORE DISCUSSION HERE ON 39 FINDINGS OF "LOW" STANDING DEAD DENSITY.**

Wetland, Riparian, and Aspen Habitat
The composition and condition of meadow and riparian habitats (including springs) in the Blue Mountains have changed substantially from the turn of the century. Vegetative changes are attributed to a combination of factors, including browsing and grazing pressures, timber management, and the disruption of natural fire cycles. The abundance and health of riparian hardwood species such as aspen, black cottonwood, water birch, cherry and willow are of special concern. Stands of aspen, while never as extensive as those found in the Rocky Mountains, were believed to have been more common in the Blues at the turn of the century than today.

Human impacts are apparent at many springs. In particular, Snapp Springs has been heavily used for camping and by livestock for many years. Overgrazing and trampling of wet meadow habitat by cattle and horses and the garbage of generations has severely degraded this area.

"Special" Habitats
Rock outcrops and talus slopes within the drainage (mostly in the South Fork drainage) have changed very little since 1939. What has changed, is the availability of forest cover, and/or the degree of isolation surrounding some of these areas. While cover is probably not an important issue to species like the peregrine, the increased presence of roads and human activities may well have had an impact on several species, including the peregrine and the wolverine.

Species

Species-Specific Habitat Assessments
Table 38 (Current Conditions) summarizes habitat indicators used to model habitat changes in the Desolation drainage. The results of the 1939-1997 comparisons are shown in Table 70 and Figures 37-43.

Management Indicator Species

Pileated Woodpecker, (Table 70, Figure 37a, b), **American Marten** (Table 70, Figure 38 a, b).
In 1939, suitable habitat for the pileated woodpecker and marten was distributed throughout the drainage. Large blocks of reproductive habitat occurred in the upper, middle and lower portions of the watershed. Foraging habitat was plentiful and well-distributed. By 1997, foraging habitat had decreased by 60 percent for pileated woodpeckers and 74 percent for martens. Reproductive habitat has become so rare (93% and 97%, respectively) that the long-term persistence of local populations of these two species is uncertain.

Northern Three-toed Woodpecker (Table 70, Figure 39 a,b).

In 1939, foraging and nesting habitat suitable for three-toed woodpeckers were available throughout the upper two-thirds of the watershed. Reproductive habitat was concentrated primarily in SWSs B, C, D, H and I. Overall, the drainage provided adequate habitat to support several reproducing pairs. In 1997, habitat for northern three-toed woodpeckers was virtually non-existent in the lower two-thirds of the watershed. Almost all remaining habitat is currently limited to the roadless portions of the drainage. In a study of three-toed woodpeckers on the Deschutes NF in central Oregon, Goggans et al. (1988) reported home ranges of 751, 351, and 131 acres. Mature and overmature forest stands were selected for both foraging and nesting, while younger stands and logged areas were avoided. When current availability (1103 acres foraging, 114 acres reproductive) is contrasted with these research results, it is possible that the Desolation drainage may no longer support a successfully reproducing population of northern three-toed woodpeckers.

Table 70. Changes in habitat availability for selected terrestrial vertebrates, Desolation drainage, 1939-1997.

SPECIES	HABITAT COMPONENT	1939 ACRES	1997 ACRES	CHANGE: + OR – AC %)
Pileated Woodpecker	F	18,729	7,552	-11,177 (60%)
	R	8,611	608	-8,003 (93%)
	R	8,494	275	-8,219 (97%)
American Marten	F	19,583	5,044	-14, 579 (74%)
	R	8,494	275	-8, 219 (97%)
No. 3-toed Woodpecker	F	16,817	1,103	-15,714 (93%)
	R	3,990	114	-3,876 (97%)
Rocky Mtn Elk	F	27,691	45,647	+17,956 (65%)
	W R	1,723	2,030	+307 (18%)
	M C	15,871	17,208	+1,337 (8%)
	S C	24,252	4,331	-19,921 (82%)
Wolverine	F	52,381	24,758	27,623 (53%)
	R	33	26	-7 (21%)
Lynx	F	11,129	14,551	+ 3,422 (31%)
	R	7,018	275	-6,743 (96%)
No. Goshawk	F	58,565	58,296	-269 (4%)
	R	29,176	1,204	-27,972 (96%)

F = Forage, R = Reproductive, WR = Winter Range, MC = Marginal Cover, SC = Suitable Cover

Rocky Mountain Elk (Table 70, Figures 40 a,b,c,d).

Total acres of available foraging habitat for Rocky Mountain elk increased by 65 percent over the analysis period, due mostly to the combination of timber harvest and stand-replacement fires. Seeding and fertilizing over the last several years may have contributed to the 18 percent increase in winter range.

Cover trends present a mixed bag. While the data in Table 70 show a modest increase in marginal cover, comparison of Figures 40 c. and d. illustrates how that *increase* is countered by a serious *decrease* in suitable cover (down 82%).

Other Species of Concern

Wolverine

In 1939, before roads, timber harvest, livestock grazing, elk hunters and OHVs, much of the Desolation drainage provided foraging habitat for this wide-ranging predator (Table 70, Figures 41 a, b). By 1997, the combined impacts of timber harvest, fire, roading and loss of isolation had led to a decline of 53 percent in foraging habitat.

Denning habitat was historically restricted to rocky outcrops and talus slopes at the very highest elevations in South Fork Desolation subwatershed (although additional reproductive habitat was probably available in adjoining SWSs outside Desolation). While the availability of rock and talus remained unchanged in 1997, what *had changed* was the loss of surrounding forest cover. Thus reproductive cover declined by 21 percent. There is only a very slight chance that wolverine are reproducing in the drainage, but not unlikely that the upper portions of the watershed still contribute to the home range of an individual or pair.

Lynx

Rabbits, especially snowshoe hares, are the primary prey of lynx (Table 70, Figures 42 a, b). An increase of early-successional habitats would benefit rabbit/hare populations in the drainage, accounting for the increase in lynx foraging habitat between 1939 and 1997. On the other hand, reproductive habitat for lynx is limited to old forest types at higher elevations, and the availability of this habitat has declined by 96 percent.

Goshawk

Results of the Paradox analysis indicated that an abundance of suitable foraging and nesting habitat (approx. 29,000 ac.) were available to goshawks in 1939 (Table 70, Figures 43 a, b). Foraging habitat stayed relatively stable over the analysis period, with only a slight decline (4%). However, by 1997 only about 1,200 acres of suitable nesting habitat in 17 remnant patches remained. The largest patch remaining was approximately 252 acres in size, compared to contiguous patches of several hundred to >1000 acres in 1939.

The change in nesting habitat acreage from 1939 to1997 constitutes a drop of nearly 96 percent. Based on the current distribution and extreme fragmentation of suitable nesting habitat, an estimate of 4-5 pairs remaining in the drainage is probably optimistic.

Rangeland Resources

The numbers of grazing cattle have been reduced in the second half of the decade, and condition and trend studies initiated in the late 1950s show that range conditions are improving (Tom Thompson, personal communication). However, complete recovery of shrub and aspen communities has been prevented by the combination of continued grazing and increased browsing from elk and deer populations, whose numbers are vastly higher now than they were when whites first settled the area (Kay 1994). Fire suppression has allowed the once open forest stands to become thick with smaller trees, blocking cattle accessibility, and putting most of the remaining cattle grazing pressure on the meadows and road sides.

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Figure 37a. Potential Available Habitat, Pileated Woodpecker - 1939.

Figure 37b. Potential Available Habitat, Pileated Woodpecker - 1997.

Figure 38a. Potential Available Habitat, American Marten - 1939

Figure 38b. Potential Available Habitat, American Marten - 1997.

Figure 39a. Potential Available Habitat, Northern Three-toed Woodpecker - 1939.

Figure 39b. Potential Available Habitat, Northern Three-toed Woodpecker - 1997.

Figure 40a. Potential Available Foraging Habitat and Winter Range, Rocky Mountain Elk - 1939.

Figure 40b. Potential Available Foraging Habitat and Winter Range, Rocky Mountain Elk - 1997.

Figure 40c. Potential Available Marginal and Suitable Cover, Rocky Mountain Elk - 1939.

Figure 40d. Potential Available Marginal and Suitable Cover, Rocky Mountain Elk - 1997.

Figure 41a. Potential Available Habitat, Wolverine - 1939.

Figure 41b. Potential Available Habitat, Wolverine - 1997.

Figure 42a. Potential Available Habitat, Lynx - 1939.

Figure 42b. Potential Available Habitat, Lynx - 1997.

Figure 43a. Potential Available Nesting Habititat, Northern Goshawk - 1939.

Figure 43b. Potential Available Nesting Habitat, Northern Goshawk - 1997.